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Advanced Simulation and Computing Fiscal Year 14 Implementation Plan, Rev. 0

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Advanced Simulation and Computing

FY14 IMPLEMENTATION PLAN

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V. ASC Level 1 and 2 Milestones

Table V-1. ASC Level 1 *Proposed* Milestones and Interfaces with Defense Programs Components from FY14–FY17

Milestone Title	Level	FY	Completion Date	Site(s)	Participating Program Offices
New Level 1 Milestone, Title TBD	1	FY15	TBD	LLNL, LANL	Science Campaigns ASC Campaign
Initial deployment of QASPR: delivery of initial validated III-V circuit predictive capability to support qualification	1	FY15	TBD	SNL	ASC Campaign
Deployment of capabilities to support full system safety assessments for abnormal thermal environments for the B61-12 LEP	1	FY16	TBD	SNL	ASC Campaign Engineering Campaigns

ASC Level 2 Milestones for FY14

Table V-2. Quick Look: Level 2 Milestone Dependencies for FY14¹

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Deliver, within the Nuclear Performance Code System, an Initial Capability for the Simulation of Output	FY14	6/30/14	IC	LLNL
TBD	Assess Performance and Scalability of a New Transport Package in Programmatic Applications	FY14	9/30/14	IC	LLNL
TBD	Assess Newly Emerging Programming and Memory Models for Advanced Architectures on Integrated Codes	FY14	9/30/14	IC	LLNL
TBD	High Explosive Models for Lawrence Livermore Material (LLM)-105-Based High Explosive Formulations	FY14	9/30/14	PEM	LLNL
TBD	LLNL Plan for Software for Sierra (Programming Model, Code Correctness, Power, Resilience, Performance Tools)	FY14	9/30/14	CSSE	LLNL
TBD	CTS-1 Market Survey Completed	FY14	6/30/14	CSSE	LLNL
TBD	Plan for Cluster Systems Software in a Tens of Thousands of Nodes/Cores Environment	FY14	9/30/14	CSSE	LLNL
TBD	Early Users on Sequoia Visualization System (Max)	FY14	12/31/13	FOUS	LLNL

¹ Factors such as FY14 Congressional Appropriations, NNSA/DP directives, and National Security considerations may necessitate a change in the current milestone set.

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Improved Physics Models in the Eulerian Applications Project Codes for Predictive Capability Framework Energy Balance II Peg Post	FY14	6/30/14	IC	LANL
TBD	User Release by the Transport Project of a Production Quality Version of the High-Order/Low-Order Transport Package	FY14	9/30/14	IC	LANL
TBD	Assessments and Improvements of Material Models Supporting the Pit Reuse Strategy and the FY15 Level 1 Milestone	FY14	9/30/14	PEM	LANL
TBD	Initial Development of a Suite-Based Simulation Bounding Capability for Boost Initiation and Burn Efficiency in Primary Performance	FY14	9/30/14	V&V	LANL
TBD	A Case Study of Highly Current Programming Methods for ASC Codes	FY14	9/30/14	CSSE	LANL
TBD	Strategic Computing Complex Facility Upgrades for Trinity Complete	FY14	9/30/14	FOUS	LANL
TBD	Implementation of Atomistic Model for Carrier Recombination in GaAs Semiconductor under Fast Neutron Irradiation	FY14	9/30/14	IC	SNL
TBD	Improved Verification and Validation through Integrated Sensitivity Analysis Workflow	FY14	6/30/14	IC, CSSE	SNL
TBD	SIERRA Performance Optimizations Based on STK with a Focus on SIERRA/SolidMechanics Explicit Transient Dynamics	FY14	9/30/14	IC	SNL

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Coupled Fluid/Structure Models Including Temperature-Dependent Aeroshell Constitutive Properties for the Prediction of an Arming, Fusing, and Firing Component Due to Clear Air Random Vibration	FY14	9/30/14	PEM, V&V	SNL
TBD	SNL Physics and Engineering Models Roadmap	FY14	9/30/14	PEM	SNL
TBD	Assess Predictive Capability for Coupled Thermal Mechanical Capability with Foam Decomposition	FY14	9/30/14	V&V	SNL
TBD	Studies to Assess Cavity System-Generated Electromagnetic Pulse Models Capability	FY14	9/30/14	V&V	SNL
TBD	Local Failure Local Recovery (LFLR): A Blueprint for a Proportional response to Local Process Failure	FY14	6/30/14	CSSE	SNL
TBD	ASC Workload Energy Efficiency: System and Application Interfaces for Measurement and Control	FY14	9/30/14	CSSE	SNL
TBD	Evaluate Application Performance on Advanced Architectures	FY14	9/30/14	IC, CSSE	LLNL LANL SNL

Milestone (ID#): LLNL Plan for Software for Sierra (Programming Model, Code Correctness, Power, Resilience, Performance Tools)		
Level: 2	Fiscal Year: FY14	DOE Area/Campaign: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: This milestone is a planning and scoping activity in preparation for the 2017 advanced technology system to be sited at LLNL. This milestone addresses plans for the post-Sequoia software environment, including the programming models, performance tools, and issues of power, resilience, code correctness, and tasking.		
Completion Criteria: A report covering the experiences with the software environment on Sequoia, information on expected bottlenecks and gaps in the software environment for the 2017 Sierra platform, and an initial plan to address those gaps.		
Customer: ASC		
Milestone Certification Method: Professional report and hand-off to ASC program		
Supporting Resources: Sequoia, CSSE, and FOUS personnel		

Milestone (ID#): CTS-1 Market Survey Completed		
Level: 2	Fiscal Year: FY14	DOE Area/Campaign: ASC
Completion Date: 6/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: A market survey will be conducted to understand the current state of the art in commodity computing cluster options.		
Completion Criteria: Market survey including results of studying technologies available from potential vendors in order to inform the CTS-1 RFP		
Customer: ASC		
Milestone Certification Method: Professional report and hand-off to ASC program		
Supporting Resources: CSSE tri-lab personnel		

Milestone (ID#): Plan for Cluster Systems Software in a Tens of Thousands of Nodes/Cores Environment		
Level: 2	Fiscal Year: FY14	DOE Area/Campaign: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: This milestone is a planning and scoping activity to determine gaps in current cluster systems software and identify development areas required to scale to a cluster with tens of thousands of nodes/cores.		
Completion Criteria: Professional documentation including the plan		
Customer: LC and ASC		
Milestone Certification Method: Plan is presented to ASC program staff at LLNL. Professional documentation including a viewgraph presentation is prepared as a record of milestone completion.		
Supporting Resources: CSSE and FOUS staff at LLNL		

Milestone (ID#): Early Users on Sequoia Visualization System (Max)		
Level: 2	Fiscal Year: FY14	DOE Area/Campaign: ASC
Completion Date: 12/31/13		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: The Max visualization and data analysis cluster will provide Sequoia users with compute cycles and an interactive option for data exploration and analysis. The system will be integrated in the first quarter of FY14 and the system is expected to be moved to the classified network by the second quarter of FY14. The goal of this milestone is to have early users running their visualization and data analysis work on the Max cluster on the classified network.		
Completion Criteria: Racks are assembled in B453, the system has been moved to the classified network, and the VisIt, Paraview, and EnSight codes have been tested on the system. A visualization user will write a memo certifying that he/she has run successful visualization jobs on Max on the classified network.		
Customer: ASC		
Milestone Certification Method: Professional report and hand-off to ASC program		
Supporting Resources: TBD		

Milestone (ID#): A Case Study of Highly Current Programming Methods for ASC Codes		
Level: 2	Fiscal Year: FY14	DOE Area/Campaign: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
<p>Description: The impact of new architectures on critical IC codes has been categorized at a high-level in terms of removing bulk-synchronous communications and increasing levels of concurrency and parallelism. A critical element in meeting these challenges is the adoption of new approaches to programming that reduce the introduction of these characteristics and simplify the programmability of future systems.</p> <p>This milestone will investigate a potential path forward for reaching these goals by developing and applying these techniques in an implementation of an ASC proxy application and/or a portion of a full IC code. In addition to improving concurrency and reducing synchronization points, approaches will be explored that enable interoperability with MPI-based codes to not only minimize the overall impact but also more importantly provide a staged migration path for existing codes.</p> <p>This effort will provide ASC IC developers with reference codes and tools that will benefit them in understanding the impact of programming techniques for next-generation architectures.</p>		
<p>Completion Criteria: Demonstration of techniques used to reduce both bulk-synchronous communications and increase the levels of concurrency within a portion of an application and/or application proxy. Performance and programmability impacts will be documented.</p>		
Customer: ASC integrated code development teams		
<p>Milestone Certification Method:</p> <p>A program review is conducted and its results are documented.</p> <p>Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion</p>		
Supporting Resources: System resources and participation of code teams and code users		

Milestone (ID#): Strategic Computing Complex Facility Upgrades for Trinity Complete		
Level: 2	Fiscal Year: FY14	DOE Area/Campaign: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: FOUS		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
Description: Upgrade the SCC facility electrical and mechanical infrastructures to support the Trinity and CTS-1 water-cooled systems.		
Completion Criteria: The electrical and mechanical upgrades are completed to support the Trinity system. Upgrades include the integration of cooling towers, heat exchanges, pumps, switchboards, and substations into existing SCC facility infrastructure.		
Customer: NNSA/ASC HQ, tri-lab weapons applications community		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: LANL facilities team, LANL support organizations		

Milestone (ID#): Local Failure Local Recovery (LFLR): A Blueprint for a Proportional Response to Local Process Failure		
Level: 2	Fiscal Year: FY14	DOE Area/Campaign: ASC
Completion Date: 6/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
<p>Description: Resilience is a crosscutting issue that spans the entire software and hardware stack, and realization of resilient applications will require a multifaceted approach. Global checkpoint/restart (CPR) has been the dominant approach to addressing resilience for many years and, although file I/O performance has not kept pace with computation and data growth, libraries such as SCR have been able to preserve global CPR APIs and semantics while taking advantage of latent locality properties in SNL's application storage and recovery patterns to hide latency. Even so, SCR is still a global model and new approaches need to be explored. Although a suitable alternative to CPR may take a long time to realize, there are elements of the problem that can be addressed early on, providing a path toward the final, long-term solution. Most important is the development and dissemination of workable resilient computing models that enable application and algorithm developers to reason about and implement new capabilities. The local-failure-local-recovery (LFLR) model is one of the most promising approaches to realize a qualitative improvement in application resilience to common system faults. LFLR relies heavily on a fundamental ability to store data persistently such that, if an MPI process is lost, the persistently stored data will be available when a new process is assigned to continue the work of the lost process. The implementation of persistent storage can be done in several ways, but SNL will focus on the API and successful use of the model. The objective is to provide the core 'persistence' capability and demonstrate how it can be used to avoid system-wide checkpoint/restart in favor of application-driven local recovery.</p>		
<p>Completion Criteria: Successful completion of execution for the Mantevo MiniFE mini-app under the simulated loss of one or more MPI processes using a prototype persistent data API and basic implementation of the API; a clearly documented list of OS/Runtime features required for realizing LFLR in a full-scale application on a future unreliable system; and a description of the strategies application developers can use to integrate LFLR resilience into their codes</p>		
<p>Customer: Sierra Team Lead. SNL will look to the lead to confirm that the approach being used will have some promise as a viable approach for future full-scale applications.</p>		
<p>Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.</p>		

Milestone (ID#): Local Failure Local Recovery (LFLR): A Blueprint for a Proportional Response to Local Process Failure

Supporting Resources: Technical support from SNL's MPI, system software, and OS research teams to facilitate clear decision making on API design and implementation.

Milestone (ID#): ASC Workload Energy Efficiency: System and Application Interfaces for Measurement and Control

Level: 2	Fiscal Year: FY14	DOE Area/Campaign: ASC
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Completion Date: 9/30/14

ASC nWBS Subprogram: CSSE

Participating Sites: SNL

Participating Programs/Campaigns: ASC

Description: Addressing anticipated ASC computational needs within reasonable power constraints requires great advances in hardware power efficiency. To achieve the greatest efficiency from next-generation hardware at scale, software at many levels will be required to coordinate and optimize the underlying hardware. While commodity pressures will drive useful innovations in this area that can be leveraged, efforts are distinguished by SNL's requirements at scale. This milestone will first identify the critical multi-level measurement requirements needed for next-generation platforms. Next, SNL will define the scope, interfaces, and information flow important to generate a power application programming interface (API) using Unified Modeling Language (UML) tools and processes. The resulting Use Case definitions will form the basis of a power API specification. Both the Use Case document and the power API specification will be socialized with other laboratories, vendors, and university collaborators for evaluation and feedback.

Completion Criteria: A review meeting of the API will be held and results recorded. As an important element in co-design activities, attendees will be drawn from the broader HPC community, including vendors, other laboratories, academia, and if possible, commercial HPC sites.

Customer: ASC platform design team members and application developers

Milestone Certification Method:

A program review is conducted and its results are documented.

Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.

Supporting Resources: Advanced Systems Technology Test Beds

Milestone (ID#): Evaluate Application Performance on Advanced Architectures		
Level: 2	Fiscal Year: FY14	DOE Area/Campaign: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: IC, CSSE		
Participating Sites: LLNL, LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: Each lab will identify two proxy applications that have been demonstrated to be representative of key performance aspects of ASC integrated codes. These proxy applications will be exercised on test beds, advanced systems, or simulators to analyze both performance and scalability issues.		
Completion Criteria: A tri-lab report will detail key performance indicators related to hardware (such as memory bandwidth or latency, and interconnection fabric performance) or software (such as runtime support for task level parallelism or DSLs, advanced compilers, or application development tools).		
Customer: ASC		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: Co-design teams from IC and CSSE		

ASC Level 2 Milestones for FY15

Table V-3. Quick Look: Level 2 Milestone Dependencies for FY15²

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Deliver Enhancements of Mesh Relaxation and Remap	FY15	12/31/14	IC	LLNL
TBD	Deliver, within the Nuclear Performance Code System, an Initial Capability for Performance Simulations to Late Time	FY15	3/30/15	IC	LLNL
TBD	Release Advanced Capabilities for Primary Modeling for Production Use	FY15	6/30/15	IC	LLNL
TBD	Strength Model Development for Reuse Applications	FY15	9/30/15	PEM	LLNL
TBD	Planning for Systems Software Environment and Applications Preparation for 2017 Hardware Platform	FY15	9/30/15	CSSE	LLNL
TBD	CTS-1 Contract Awarded	FY15	9/30/15	CSSE	LLNL
TBD	Complete B654 Livermore Computing Project	FY15	12/31/14	FOUS	LLNL
TBD	Production Release of the Eolus Diagnostics Codes for the Predictive Capability Framework Boost and Secondary Peg Posts	FY15	6/30/15	IC	LANL
TBD	Initial Release by the Setup Project of Production Quality Version of Linking Engineering to Physics Simulation Codes	FY15	9/30/15	IC	LANL

² Factors such as FY15 Congressional Appropriations, NNSA/DP directives, and National Security considerations may necessitate a change in the current milestone set.

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Replacement of the Legacy Opacity Code LEDCOP with the ATOMIC Opacity Code for Production of New Opacities	FY15	9/30/15	PEM	LANL
TBD	Delivery of Improved Physics Capabilities Supporting FY16 Initial Conditions II Peg Post	FY15	9/30/15	PEM	LANL
TBD	Secondary Validation Suite Support for Energy Balance II: Identifying Focus Areas for Detailed Investigations	FY15	3/31/15	V&V	LANL
TBD	Site Prep for Trinity	FY15	6/30/15	CSSE, FOUS	LANL
TBD	Coupled Aerodynamic Loading and Structural Response Capabilities in SIERRA to Perform Production Calculations in Support of Normal Mechanical Component Captive Carry Environments	FY15	9/30/15	IC, PEM	SNL
TBD	New TRILINOS Solver Stack with Support for Threading and Accelerator-Based Architectures in Production Solvers	FY15	6/30/15	IC	SNL
TBD	Intrinsic Solution Verification Capabilities Based on Improved, Automated Mesh Refinement Algorithms and Code Coupling	FY15	9/30/15	IC, V&V	SNL
TBD	Direct Simulation Monte Carlo Simulation of a Massively Parallel, Chemically Reacting, 3D Re-Entry Flow	FY15	9/30/15	PEM	SNL
TBD	First Release of DAKOTA Adaptive Sampling Methods for Refinement of Kriegering and Latin Hypercube Sampling	FY15	9/30/15	V&V	SNL

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Propagate Uncertainties in Reentry Coupled Simulations to Component (Gas Transfer System or NG or Stronglink) Response Metric	FY15	9/30/15	V&V	SNL
TBD	Using Performance Modeling and Simulation Tools and Techniques to Gauge Key Application Performance Characteristics of the Trinity Platform	FY15	9/30/15	CSSE	SNL
TBD	Demonstration of Fault-Tolerant Programming Model at Scale	FY15	9/30/15	CSSE	SNL
TBD	Integrate the Tri-Lab Linux Capacity Cluster-3 Clusters into SNL Environment	FY15	9/30/15	FOUS	SNL
TBD	Demonstrate Performance and Software Benefits from Proxy Apps and Architecture Explorations of FY14	FY15	9/30/15	IC, CSSE	LLNL LANL SNL
TBD	ACES Initial Trinity Delivery	FY15	9/30/15	CSSE	LANL SNL
TBD	Feedback to Vendors Key Bottlenecks in Performance and Demonstrate an Initial Set of Performance Improvements for the Architectures Represented by Hardware Test Beds	FY15	9/30/15	CSSE	LLNL LANL SNL
TBD	Deploy the TOSS Stack and Other CCE Tools for the New CTS-1 System	FY15	9/30/15	FOUS	LLNL LANL SNL

Milestone (ID#): Planning for Systems Software Environment and Applications Preparation for 2017 Hardware Platform		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: Building on the FY14 LLNL plan for Sierra, this milestone addresses hardware and software plans for the 2017 system at LLNL. It includes the completion of the Request for Proposals for the 2017 platform, including systems software and development environment. A code migration and application preparation strategy, including expected programming model and tools support, will also be developed.		
Completion Criteria: A report covering the strategy for applications preparation and a description of the systems software and development environment.		
Customer: ASC		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The “handoff” of the developed capability (product) to a nuclear weapons stockpile customer is documented.		
Supporting Resources: LLNL CSSE staff, Sequoia, and other advanced architecture resources		

Milestone (ID#): CTS-1 Contract Awarded		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: Based on tri-lab CTS-1 process and review, LLNL successfully awards the procurement for the next-generation Tri-Lab Linux Commodity Technology Systems (CTS-1).		
Completion Criteria: Signed contract		
Customer: ASC		
Milestone Certification Method: Signed contract		
Supporting Resources: ASC CSSE and FOUS personnel, LLNL procurement staff		

Milestone (ID#): Complete B654 Livermore Computing Project		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 12/31/14		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: Early users will be on the CTS-1 machines at LLNL.		
Completion Criteria: CTS-1 racks have been assembled in the new B654 facility, the system has been placed on the network, and at least one user has ported their code. A user will write a memo certifying that his/her code has run on the CTS-1 cluster.		
Customer: ASC/LLNL		
Milestone Certification Method: Professional report and hand-off to ASC program		
Supporting Resources: CTS-1, facilities team, FOUS and CSSE staff		

Milestone (ID#): Site Prep for Trinity		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 6/30/15		
ASC nWBS Subprogram: CSSE, FOUS		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
Description: Design, build, and integrate under-floor water-cooling distribution system for Trinity/ATS-1 platform.		
Completion Criteria: The Trinity platform is hooked up to and being cooled by the water-cooling distribution system.		
Customer: NNSA/ASC HQ, tri-lab weapons applications community		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: LANL facilities team, LANL support organizations		

Milestone (ID#): Using Performance Modeling & Simulation Tools and Techniques to Gauge Key Application Performance Characteristics of the Trinity Platform		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
<p>Description: This milestone has several important goals. SNL wants to develop SST models for Trinity features in advance of the actual physical system deployment for two key reasons: 1) to provide the application development teams a head start on analyzing the behavior of their codes on Trinity (before it is actually available), and 2) to set a baseline for predictive performance of SST for key components of the Trinity system. These are obviously interconnected, and both rely on the core ability to model aspects of application's performance on SST prior to Trinity's full deployment. The first key deliverable is hence the development of SST models of important Trinity features and the V&V of those models, recognizing that the completion of that V&V may only be possible after Trinity is deployed and comparative performance data is collected and reconciled with the SST Trinity models. SNL will select one or more ASC applications or mini-apps to focus the work, and data will be collected on the SST simulator and documented such that SNL can later (when the actual Trinity data is available) rigorously compare and analyze the SST's predictive capability in this context. The work is expected to focus on the macro-scale components of SST but may not be restricted to that; final determination will be made closer to the milestone date. Once the application performance analysis is complete and the SST simulator 'calibrated' via V&V processes, SNL expects to subsequently improve the SST models as needed so that they can be used for a wide variety of application performance analysis work.</p>		
<p>Completion Criteria: Completion of program review and draft document to be published as a SAND report when V&V analysis is complete</p>		
<p>Customer: ASC application developers preparing for Trinity</p>		
<p>Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.</p>		
<p>Supporting Resources: Access to Trinity after milestone to perform the V&V analysis</p>		

Milestone (ID#): Demonstration of Fault-Tolerant Programming Model at Scale		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
<p>Description: There is a general consensus that despite best efforts on all parts, the application will still be required to account for faults ‘below’ it. That is, SNL does not anticipate that the system comprised of the software stack and hardware (minus the application) will be (or appear to be) entirely stable from the application’s perspective. New program models are being explored now, including task-DAG approaches, combined with algorithmic changes that induce better fault tolerance. Currently, these are being done at small scale on what amounts to semi-realistic test problems. However, the results indicate that these approaches may have significant promise for scalable, fault-tolerant applications programming models, and SNL anticipates developing realistic-scale applications in the next two years as proof of concept for the approach. This milestone will include a demonstration of one or more novel approaches to fault-tolerant programming models, on a realistic application, at scale, on a capability-class system as well as analysis of its performance on the SST performance simulator. For the latter, SNL will analyze the response to faults in the system and characterize the scalability and performance based on at least one realistic-scale application and system configuration.</p>		
Completion Criteria: Completion of program review and final document published as a SAND report		
Customer: ASC application developers		
<p>Milestone Certification Method:</p> <p>A program review is conducted and its results are documented.</p> <p>Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.</p>		
Supporting Resources: Cielo or other higher scale HPC platforms		

Milestone (ID#): Integrate the Tri-Lab Linux Capacity Cluster-3 Clusters into SNL Environment		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: FOUS		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: TLCC3 resources will be installed, accepted from the provider, integrated into the network environment, and ready for General Use within two calendar quarters following delivery to SNL facilities.		
Completion Criteria: TBD		
Customer: TBD		
Milestone Certification Method: TBD		
Supporting Resources: TBD		

Milestone (ID#): Demonstrate Performance and Software Benefits from Proxy Apps and Architecture Explorations of FY14		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: IC, CSSE		
Participating Sites: LLNL, LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: For at least two hardware architectures, algorithmic improvements to applications will be explored to address key performance bottlenecks identified in FY14. A report on successful and unsuccessful attempts to increase performance will be completed as lessons learned.		
Completion Criteria: TBD		
Customer: TBD		
Milestone Certification Method: TBD		
Supporting Resources: TBD		

Milestone (ID#): ACES Initial Trinity Delivery		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: CSSE		
Participating Sites: LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: A substantial portion of the Trinity platform hardware has been delivered. Pre-delivery testing of the hardware at the vendor site has been completed as well as post-delivery testing at the site in Los Alamos. These tests include some application codes that are used to find system problems. The system portions delivered are ready to be connected together as one system.		
Completion Criteria: TBD		
Customer: TBD		
Milestone Certification Method: TBD		
Supporting Resources: TBD		

Milestone (ID#): Feedback to Vendors Key Bottlenecks in Performance and Demonstrate an Initial Set of Performance Improvements for the Architectures Represented by Our Hardware Test Beds		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL, LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: For two hardware test bed architectures, the key performance bottlenecks will be identified for ASC's proxy applications and these will be communicated to the vendors. Algorithmic improvements will be explored for that combination of proxy applications and hardware, and a report on successful and unsuccessful attempts to increase performance will be completed as lessons learned.		
Completion Criteria: TBD		
Customer: TBD		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: TBD		

Milestone (ID#): Deploy the TOSS Stack and Other CCD Tools for the New CTS-1 System		
Level: 2	Fiscal Year: FY15	DOE Area/Campaign: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL, LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: TBD		
Completion Criteria: TBD		
Customer: TBD		
Milestone Certification Method: TBD		
Supporting Resources: TBD		

ASC Level 2 Milestones for FY16

Table V-3. Quick Look: Level 2 Milestone Dependencies for FY16³

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Verify and Validate a New Multiphase Capability	FY16	12/31/15	IC	LLNL
TBD	Evaluate Advanced Architecture Evolution for Integrated Codes	FY16	9/30/16	IC	LLNL
TBD	Deliver Initial Capability for Unstructured Adaptive Mesh Refinement	FY16	12/31/15	IC	LLNL
TBD	Equation of State Table Generation Tools that Enable Rapid Turnaround in a Kinetics-Aware Framework	FY16	9/30/16	PEM	LLNL
TBD	Applications Preparation and Outreach for CORAL 2017 LLNL Machine	FY16	12/31/15	CSSE	LLNL
TBD	Complete 15-MW B453 Power Upgrade	FY16	9/30/16	FOUS	LLNL
TBD	Prepare Select ASC Applications for the Trinity System	FY16	9/30/16	IC, CSSE	LANL
TBD	Demonstration by the Lagrangian Application Project of a 3D Implosion/Explosion Simulation Capability	FY16	3/31/16	IC	LANL
TBD	Delivery of Improved Physics Capabilities Supporting FY17 Secondary Performance I Peg Post	FY16	9/30/16	PEM	LANL
TBD	Diagnostic Data Analysis, Uncertainty, and Modeling in an ASC Era	FY16	9/30/16	V&V	LANL

³ Factors such as FY16 Congressional Appropriations, NNSA/DP directives, and National Security considerations may necessitate a change in the current milestone set.

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Exploiting Advanced File Systems in Integrated Codes	FY16	6/30/16	CSSE	LANL
TBD	Prepare ASC Applications for the Trinity System	FY16	12/31/15	IC, CSSE	LANL
TBD	3D Particle Radiation Transport Calculations for Box Internal Electromagnetic Pulse	FY16	6/30/16	IC	SNL
TBD	A Demonstrated Flexible Coupling between SIERRA Modules (Combinations of Full Coupling and Segregated Multi-Physics)	FY16	6/30/16	IC	SNL
TBD	Abnormal Thermal: Develop Conductive Burn Model for PBX9502	FY16	TBD	PEM	SNL
TBD	Develop and Apply First Principles Methods Density Functional Theory/Quantum Molecular Dynamics and QMC to Develop an Integrated Suite of Equation of State and Transport Models for Aluminum, Including Support for Uncertainty Quantification and Quantification of Margins and Uncertainties	FY16	TBD	PEM	SNL
TBD	Using One of the Nuclear Weapons Full Systems Models, Show an Application of Adaptive Sampling Methods for Refinement Using Kriegering and Latin Hypercube Sampling	FY16	9/30/16	V&V	SNL
TBD	Application of a Stencil Approach for Tolerating Silent Errors by ASC codes	FY16	9/30/16	CSSE	SNL
TBD	Impact of Advanced Memory Architectures on ASC codes	FY16	9/30/16	CSSE	SNL
TBD	Trinity System Integration Readiness	FY16	12/31/15	CSSE, FOUS	LANL SNL

Milestone (ID#): Applications Preparation and Outreach for CORAL 2017 LLNL Machine		
Level: 2	Fiscal Year: FY16	DOE Area/Campaign: ASC
Completion Date: 12/31/15		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
<p>Description: Building on the FY15 Sierra systems software and applications preparations planning, the Sierra Applications Preparation (SAP) effort will extend the knowledge base, documentation, and training to enable ASC tri-lab code teams to use the 2017 Sierra system. SAP will actively engage tri-lab code teams to address their needs in porting codes. Several multi-physics codes will be engaged to characterize performance, analyze issues, and develop strategies for improving performance on the platform. A deployment plan will be developed, including initial testing and validation of the tool suite.</p>		
<p>Completion Criteria: A report covering the performance findings and recommended techniques and strategies for the codes studied</p>		
Customer: ASC IC		
<p>Milestone Certification Method:</p> <p>Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.</p> <p>The “handoff” of the developed capability (product) to a nuclear weapons stockpile customer is documented.</p>		
Supporting Resources: Simulators and test beds to simulate the Sierra system		

Milestone (ID#): Complete 15-MW B453 Power Upgrade		
Level: 2	Fiscal Year: FY16	DOE Area/Campaign: ASC
Completion Date: 9/30/16		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: In preparation for siting the 2017 system, B453 requires a power upgrade. This milestone will provide the necessary power projected for the Sierra machine to be sited in B453 in 2017.		
Completion Criteria: Power upgrade complete and tested		
Customer: ASC LLNL		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The “handoff” of the developed capability (product) to a nuclear weapons stockpile customer is documented.		
Supporting Resources: FOUS personnel and contracted electrical specialists		

Milestone (ID#): Exploiting Advanced File Systems in Integrated Codes		
Level: 2	Fiscal Year: FY16	DOE Area/Campaign: ASC
Completion Date: 6/30/16		
ASC nWBS Subprogram: CSSE		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
Description: File systems are evolving into more complex but more capable systems featuring hierarchical levels of conventional and non-traditional storage, and processing elements (for example, “burst buffer” architectures). LANL will explore the consequences for integrated codes, develop best practices, and demonstrate an API that allows applications to effectively exploit the new systems while insulating them from file system implementation details.		
Completion Criteria: TBD		
Customer: TBD		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: TBD		

Milestone (ID#): Prepare ASC Applications for the Trinity System		
Level: 2	Fiscal Year: FY16	DOE Area/Campaign: ASC
Completion Date: 12/31/15		
ASC nWBS Subprogram: IC, CSSE		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
Description: Demonstration by the Lagrangian Application Project of a 3D implosion/explosion simulation capability on Trinity.		
Completion Criteria: TBD		
Customer: TBD		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: TBD		

Milestone (ID#): Application of a Stencil Approach for Tolerating Silent Errors by ASC Codes		
Level: 2	Fiscal Year: FY16	DOE Area/Campaign: ASC
Completion Date: 9/30/16		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
<p>Description: An increasingly important type of failure in HPC involves deviations from intended behavior that occur silently. With extreme-scale computing, these previously rare “silent errors” will become more commonplace. SNL is developing novel approaches to address a significant concern in this space: silent data corruption (SDC), such as bit flips. Ongoing research seeks to leverage stability properties of physical systems to engineer related SDC stability properties into digital algorithms for physics simulation. This work has demonstrated the potential for a “robust stencil” approach that can discard an outlier point from a neighborhood in a discretized equation and compute an update of sufficient accuracy from the remaining points. Demonstrations have been run at small scale with simplified solvers, but the underlying theory suggests that the approach can be generalized to more practical solvers for ASC applications and scaled to large numbers of compute nodes. Starting in FY14, SNL anticipates working over the next three years on the mathematical and algorithmic innovations needed to bring such physics-based SDC tolerances into HPC practice. For this milestone, SNL will demonstrate a representative robust simulation application at scale on an advanced technology system. SNL will evaluate the performance and error tolerance of this application with respect to one or more relevant types of SDC (for example, memory or network bit flips), using emulated error injection or—if present and able to be characterized—actual system errors.</p>		
Completion Criteria: Completion of program review and final document published as a SAND report		
Customer: ASC application developers		
<p>Milestone Certification Method:</p> <p>A program review is conducted and its results are documented.</p> <p>Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.</p>		
Supporting Resources: Access to an advanced technology HPC system for development and ultimate demonstration		

Milestone (ID#): Impact of Advanced Memory Architectures on ASC Codes		
Level: 2	Fiscal Year: FY16	DOE Area/Campaign: ASC
Completion Date: 9/30/16		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
<p>Description: Develop a next-generation memory system architecture to increase performance of ASC applications in partnership with industry and academia. SNL is performing architectural analysis and supplying application and system software expertise. Analysis of this system shall show improvements in memory system performance or power compared to conventional memory systems. Experiments shall also be used to explore the memory system design space (including bandwidth, capacity, and topology); determine the overall impact on the applications, system software, and system balance; and determine the impact of performing some computation, synchronization, or data movement operations in the memory system. This milestone will focus on the performance of key ASC application kernels and algorithms and will use a variety of tools available at the time, which may include the SST simulator, hardware emulation prototypes such as FPGAs, or hardware evaluation test beds.</p>		
<p>Completion Criteria: Completion of program review and final document published as a SAND report</p>		
<p>Customer: ASC Code Developers</p>		
<p>Milestone Certification Method:</p> <p>A program review is conducted and its results are documented.</p> <p>Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.</p>		
<p>Supporting Resources: Advanced Architecture Test Beds</p>		

Milestone (ID#): Trinity System Integration Readiness		
Level: 2	Fiscal Year: FY16	DOE Area/Campaign: ASC
Completion Date: 12/31/15		
ASC nWBS Subprogram: CSSE, FOUS		
Participating Sites: LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: Ready Trinity for integration into the LANL computing center. Deliver and install system hardware. Deliver, test, and demonstrate system software. Complete onsite capability scaling testing. Ready Trinity for onsite integration into the local and remote computing infrastructure, including the user software environment.		
Completion Criteria: Follows the ASC Level 2 Milestone criteria for capability platforms: system hardware deliveries from vendor to site are complete, including the basic hardware to integrate “the system” as contractually defined; installation of the system by the contractor onsite to the extent that is contractually required is substantially complete; in general, contractual requirements for formal hardware acceptance have been substantially completed; system software needed for basic operation of the system is delivered, tested, and demonstrated to be operational; vendor has completed onsite capability scaling testing and demonstration; and system is ready to begin onsite integration into local computing environment.		
Customer: NNSA/ASC HQ, tri-lab ASC program managers responsible for CCCs, SSP, tri-lab weapons applications community		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: CSSE, FOUS, platform funding, ACES program managers, LANL facilities		